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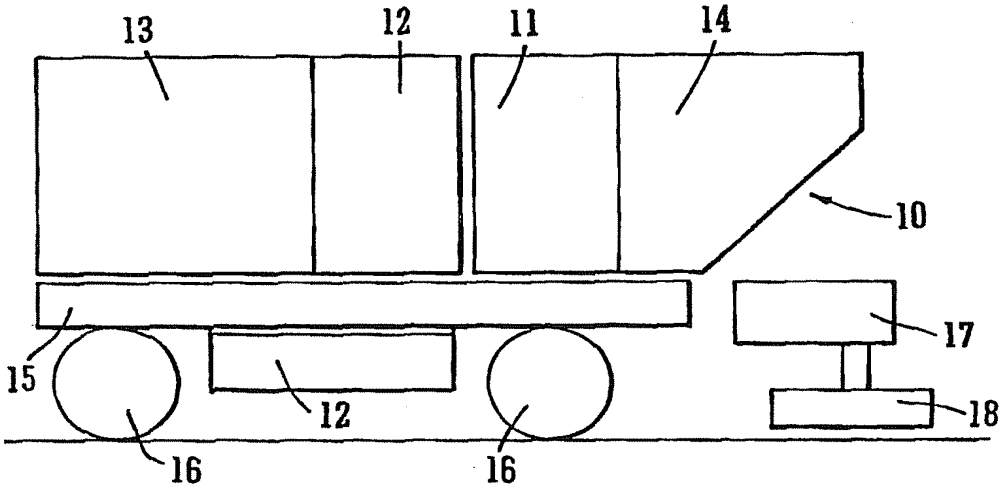
(54) Title: REMOVAL OF SURFACE MARKINGS



(57) Abstract

Paint markings are removed from a road surface by apparatus (10) having a plurality of nozzles through which water is supplied at ultra high pressure, the nozzles (18) being rotated so that a curvilinear pattern is made on the road.

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REMOVAL OF SURFACE MARKINGS

This invention relates to the removal of markings from surfaces. It is particularly concerned with the removal of markings from roads and other surfaces, e.g. runways, that carry traffic. For convenience such markings will herein be referred to more specifically as 'road markings' although it will be appreciated that the invention is not intended to be limited to removal of markings from roads. It has general applicability to horizontal, sloping and vertical surfaces.

Road markings in the form of applied bands of particular colours are extremely well known and widely used throughout the world. They inform road users of the existence of particular zones on the road and, for example, divide roads into lanes and warn of temporary or long term hazards. They are usually applied in linear continuous and/or discontinuous bands or in 'hatched' areas within a perimeter that may be bound by straight lines and/or curves.

The materials used to form the road markings are, for example, rubberised or plasticised compositions, which may contain ballotini for good light reflection, especially in the dark, and may be pigmented to provide a variety of different coloured markings to indicate different types of zones and hazards.

After their application to a road surface, there is often a need for a change to or complete removal of the markings. This may be due to changed traffic circumstances, re-routing of roads, changes to junction layouts and so on.

In order to remove road markings it is currently conventional practice to use jets of water at pressures from about 100 up to about 1400 bar at flow rates up to about 200 litres per minute. Such techniques are not entirely successful. The impact of the water jets has a combined abrasive action and impact or hammer action. The hammer action can result in undesirable effects, particularly if the markings to be removed contain matter that is harder than the supporting road surface. Thus the supporting surface may be deteriorated and, for example, ballotini may be driven into the surface instead of being removed from it, thereby leaving visible traces that could cause confusion to drivers.

Moreover, it is also conventional practice to add abrasives or chemical solvents to the water jets to assist removal of the markings and this can result in erosion or denaturing of the road surface, which can harmfully affect visual and driving conditions while adding to environmental pollution.

It is, therefore, one object of the present invention to provide an improved means of removing surface markings, which overcomes or reduces the disadvantages mentioned above of conventional means.

Accordingly, the invention provides an apparatus for the removal of markings from a surface, the apparatus comprising a support carrying a plurality of nozzles, a pump to supply a fluid in jets through the nozzles at ultra high pressure, some at least of the nozzles being rotated whereby the jets describe a curvilinear pattern on the surface, and means to propel the apparatus relative to the surface.

The fluid will normally be water alone. We have found that additives such as chemicals or abrasives are not normally required when using the apparatus of the invention but their possible use in particular circumstances is not excluded.

By ultra high pressure in this specification is meant a pressure of greater than 1400 bar, preferably from 2400 bar upwards, e.g. to 3600 bar or even higher.

Preferably the nozzles are mounted on the support on two or more rotating distributors. Each distributor may have a multi-arm and multi-nozzle assembly. The distributors may be adjustable separately as regards their precise position, height and orientation to suit the particular surface and markings to be treated.

The nozzles are preferably of low diameter, e.g. less than 1 mm in diameter, preferably less than 0.75 mm and especially less than 0.5 mm diameter. By this means water consumption can be kept relatively low, e.g. several centilitres per nozzle per minute while still not normally requiring any additives.

Preferably the rotating distributors are arranged such that the incidence of the jets on the marked surface covers the whole of the marked area with cross-passes of the jets and with different angles of incidence of the jets. By arranging for the jets to impinge at closely situated and non-regular patterns of impact, the marked coating on the surface can be broken into fine particles and embedded ballotini are loosened from their supporting medium.

The use of at least two multi-arm, multi-nozzle rotating distributors, with use of nozzle diameters that can be changed to be larger or smaller to suit the particular

requirements, can ensure a very short jet impact time at any given point on the surface. As indicated above, some of the jets may be at different angles to the surface, e.g. some are preferably perpendicular and some a few degrees from perpendicular. The different nozzle angles and staggered intensities of impact facilitate loosening of ballotini and removal of the entire marking coating from the surface.

The support to carry the nozzles and their distributors may be adjustable to maintain the plane of rotation of the nozzles parallel to the surface carrying the markings and at a controlled distance from the surface or to maintain that plane at a small angle thereto.

The invention, therefore, can provide an apparatus which can produce ultra high pressure water jets whose rotation and trajectories can be synchronised to avoid collision. The distributors can provide staggered power levels and can be changed rapidly, according to the markings to be removed, without need for dismantling either the field of scope or intensity of the cutting action.

Each distributor in addition to rotating about its own axis may be driven in a rectilinear or circular displacement movement, each movement being able to be continuous or alternating so as to systematically cover the whole of the marked area to be deleted.

The means to propel the apparatus relative to the surface is preferably a mobile platform which is integrated in the apparatus. The platform is preferably driven by a thermal engine with its own fuel reserves and may have the means to carry all other

requirements to ensure autonomy of action for a specific period of, say, from 4 hours to 36 hours or more.

The platform may be equipped with:

- secure directional devices applicable to each axle to enable maximum manoeuvrability relative to the markings to be removed;

- a complete, ergonomic control station for management of the following;

- of its positioning movements between two work zones whether they are close together or not;

- of the conditions of the operating environment and for the security of the equipment with regard to climactic conditions (intense cold or heat);

- for a direct view of the markings to be removed (irrespective of the possible remote monitoring accessories).

The process equipment integrated into the platform may include:

- the ultra high pressure generator with its own ancillaries;

- a "process" water tank

- the ultra high pressure tool supports for their positioning above (opposite) the markings to be removed;

- the regulation and control devices.

Other optional equipment that may be provided in the apparatus includes:

- A conventional dry aspirator device for the debris of the removed material with possible recuperation of the process water.
- For applications in zones which are very far from any replenishment point, and provided that all on-board reserves are compatible, the platform may accommodate a process water retreatment device which results in separation of the residues.

- A rapid "drying" device for the surface to enable new markings to be made immediately after the removal operation, which markings satisfy a new technical specification.

The operation of the apparatus of the invention is preferably controlled by a programmable logic controller (PLC) which makes it possible to adapt immediately to the work to be carried out. The operation can be continuous or discontinuous according to requirements.

Control of the activation of the ultra high pressure jets may be governed by a procedure guaranteeing the correct regulation of the relative speeds (rotation of the distributors/movement of the platform) so that at no time will a jet be stationary on a

particular point of the surface to be regenerated so that there is no risk of the surface being damaged.

The use of the apparatus is preferably controlled by an on-board operator for security reasons, particularly when the work to be carried out is close to traffic.

The apparatus may be adapted for use via remote control using camera assistance. It may be adapted to entirely automatic use under the control of an expert system of artificial vision guiding it in a precise displacement zone in a programmed or random manner. In this way, one or more devices according to the invention can be controlled by a single operator in order to adapt to the general rate of progress of the worksite, e.g. concerning the road network, thus minimising the time for which traffic zones are immobilised.

Reasonable and responsible use of the water under ultra high pressure requires the action of the jets of water to be continuously controlled and that measures to protect the surface be taken without delay in the event of a failure. The apparatus of the invention may be fitted with sensors which control the continuity of rotation (at a minimum speed for the nozzle-support distributors allowing the delivery of the water jets). If the security conditions for the support cease to be met, the apparatus can, therefore, immediately make itself secure and signal the defect.

The apparatus of the invention is suitable for use on many different surfaces, e.g. macadam, concrete, asphalt, roads and runways, garages, aprons, decks, special zones for intensive braking or fuel loading and, as stated above, on horizontal, sloping or vertical surfaces.

In another aspect there is provided a method of removing markings from a surface, comprising rotating nozzles so as to direct fluid under ultra high pressure on to the surface and moving the nozzles across the surface.

Preferably the fluid is water which is preferably at a pressure greater than 1400 bar, preferably from 2400 bar, and even up to 3600 bar and above.

Embodiments of the invention will now be described by way of illustration only with reference to the accompanying diagrammatic drawings in which:-

Figure 1 is a in side elevation of one apparatus according to the invention;

Figure 2 is a diagrammatic representation of a portion of an apparatus of Figure 1 showing the relative positions of distributors;

Figure 3 is a similar representation in plan view from underneath showing two groups of nozzles and their supports;

Figure 4 is a side elevation of the arrangement shown in Figure 2;

Figure 5 is a side elevation similar to Figure 4 showing different orientations of the nozzles;

Figure 6 is a side elevation showing the relative position of two distributors used in the invention;

Figures 7, 8 and 9 are diagrammatic illustrations showing the effect of jets from different angular orientations of nozzles on the surface being treated;

Figures 10, 10A; 11, 11A and 12, 12A are illustrations of the effect of the jets from different alignments of adjacent groups of nozzles.

In Figure 1 an apparatus 10 of the invention comprises a self-contained mobile unit having an engine compartment 11, water and energy tanks 12, an ultra high pressure pump 13 and a cabin and control regulation centre 14 mounted on a frame 15 carried on driving and directional wheels 16.

Mounted at the front of frame 15 is a rotatable tool support assembly 17 carrying groups of nozzles 18.

As shown the tool support assembly is directed downwardly for treatment of a road surface but it will be appreciated that it could equally well be directed horizontally for the treatment of a vertical wall.

In Figure 2 is shown schematically a single nozzle support assembly 20 mounted on a distribution arm 21 within a casing 22. A port 23 in the roof of the casing leads to the ultra high pressure water supply. As shown the nozzle support is rotatable on its arm about vertical axis X - X. Jets 24 of water are shown issuing at different angles from the nozzles mounted in support 20.

In Figure 3 is shown from underneath two groups of four nozzles 25A, B, C, D and 26A, B, C, D. A nozzle of each group is mounted at the end of one of four cruciform arms 27, 28 and, as shown, the arms of each cruciform group rotate in synchronism with the other group whereby the paths of the nozzles on rotation overlap without collision.

In Figure 4 a nozzle support 30 carries four nozzles 31A, B, C, D with the nozzles being operated under different power levels or pressures as indicated by the different lengths of jets 32A, B, C, D.

In Figure 5 a similar nozzle support 30A has nozzles 31E, F, G, H mounted to operate at different angles as shown by jets 32E, F, G, H of which only jet 32E is vertical.

In Figure 6 are shown two side by side nozzle support distributors 35, 36 inside a casing 37. As shown distributor 35 has a single arm 38 at the end of which are mounted one or more nozzles 39. Distributor 36 has two arms 40, 41 at the end of each of which are mounted nozzles 42, 43 respectively. Arm 38 rotates about vertical axis Y - Y and arms 40 and 41 about vertical axis Z - Z. As shown nozzle(s) 39 are mounted a height 'a' above the lowermost extent of casing sidewall 37A and nozzles 42 and 43 are mounted a distance 'b' above that lowermost extent. As required, 'a' and 'b' may be equal or different.

Figures 7, 8 and 9 show the effects of jets from different nozzle angles on a coated marking layer 50 containing ballotini 51. In Figure 7 nozzle support 52 contains four nozzles providing four vertical jets 53A, B, C, D of water. As shown, where the jets

53C, 53D do not strike ballotini, they penetrate deeply into the marking layer 50. Jet 53A has struck a ballotini 51A deep inside layer 50 creating a void 54 around it and jet 53B has stuck a ballotini SIB at the surface of the layer. It will be appreciated that this represents a simplified, stylised illustration of the effect in practice on a small portion of the surface.

In Figures 8 and 9 are shown successive passes of the apparatus over layer 50. The first pass, shown in Figure 8, shows the effect of jets 55A, B, C, D emanating at different angles from nozzle support 56. The effect of the second pass is shown in Figure 9, with the nozzle support advanced a little to the right. As can be seen, some ballotini have already been removed as has a significant portion of layer 50. Further passes will completely remove layer 50 and all ballotini 51.

In Figure 10 is shown an alignment of two groups 60, 61 of nozzles 62A, B, C, D and 63A, B, C, D respectively similar to that shown in Figure 3. The axes of rotation 64, 65 respectively of the two groups of nozzles lie along a line corresponding to the central longitudinal axis of a continuous band 67 of marking material. The apparatus is moved along band 67 in the direction of arrow A while the nozzles are rotated about their axes and ultra high pressure water jets impact the surface of the band. The pattern of cuts into the depth of the band is of high density as shown in the side view Figure 10A.

In Figure 11 the two groups of nozzles 68, 69 are aligned so that their axes of rotation 70, 71 respectively lie along a line extending at about 45° to the longitudinal axis of band 67. As shown in the side view of Figure 11A, a medium density of cuts is obtained.

In Figure 12 the two groups of nozzles 72, 73 are aligned so that their axes of rotation 74, 75 respectively lie on a line perpendicular to the longitudinal axis of band 67. As shown in side view in Figure 12A, a lower density of cuts is obtained.

It will be appreciated that the alignments of the groups of nozzles, the angles of the jets and their pressure can all be varied and many combinations are possible but the skilled man will readily be able to determine the optimum requirements for any particular circumstances.

In the embodiments shown above, the direction of movement of the apparatus has been shown as rectilinear in the longitudinal direction of a continuous straight line band. However, it will be appreciated that the invention is not so limited and other possible movements and combinations of movements can readily be utilised. For example, referring again to Figure 1, the support assembly platform 17 may be constrained to move with the apparatus 10 in a straight line ahead (or backwards) or it may be moved along a curved path. The tool assembly 18 of groups of nozzles may rotate about their support axis while being carried rectilinearly or on a curved trajectory with the platform. Thus, for example, diagonal and crenellated movement across a marked area of surface to be removed can be programmed as desired and other, more complex movements can be arranged as desired.

CLAIMS

1. An apparatus for the removal of markings from a surface, the apparatus comprising a support carrying a plurality of nozzles, a pump to supply a fluid in jets through the nozzles at ultra high pressure, some at least of the nozzles being rotated whereby the jets describe a curvilinear pattern on the surface, and means to propel the apparatus relative to the surface.

2. An apparatus according to Claim 1, in which the pump supplies the fluid at a pressure greater than 1400 bar.

3. An apparatus according to Claim 2, in which the pump supplies the fluid at a pressure of from 2400 bar to 3600 bar.

4. An apparatus according to Claim 1, 2 or 3, in which the nozzles are mounted on the support on two or more rotating distributors.

5. An apparatus according to Claim 4, in which each distributor has a multi-arm and multi-nozzle assembly.

6. An apparatus according to Claim 4 or 5, in which the distributors are adjustable separately in respect of position, height, orientation and/or power of jet.

7. An apparatus according to any preceding claim, in which the nozzles are of diameter less than 0.75 mm, preferably less than 0.5 mm.

8. An apparatus according to any one of Claims 4 to 7, in which the rotating distributors are arranged such that the incidence of the jets on the marked surface covers the whole of the marked area with cross passes of the jets and with different angles of incidence of the jets.

9. An apparatus according to any preceding claim, in which the support is adjustable whereby the plane of rotation of the nozzles may be parallel to the surface carrying the markings or at a small angle thereto.

10. An apparatus according to any one of Claims 4 to 9, in which each distributor in addition to rotating about its own axis may be driven in a rectilinear or curvilinear displacement movement, each movement being continuous or alternating.

11. An apparatus according to any preceding claim, in which the means to propel the apparatus relative to the surface is a mobile platform which is integrated into the apparatus.

12. An apparatus according to Claim 11, in which the platform is driven by a thermal engine with its own fuel reserves.

13. An apparatus according to Claim 11 or 12, in which the platform has an ergonomic control station to control inter alia positioning movements between

two work zones; security of the equipment with respect for extremes of temperature, and a direct view of the markings to be removed.

14. An apparatus according to Claim 11, 12 or 13, in which the platform includes one or more of:

an ultra high pressure generator;
a process tank for the fluid;
ultra high pressure tool supports and regulation and control devices.

15. An apparatus according to Claim 11, 12, 13 or 14, in which the platform includes a dry aspirator device for the removed debris.

16. An apparatus according to any one of Claims 11 to 15, in which the platform includes a drying device for the surface from which the markings are removed.

17. An apparatus according to any preceding claim, whose operation is controlled by a programmable logic controller.

18. An apparatus according to any preceding claim, which includes sensors to monitor the action of the jets and to signal any defects.

19. A method of removing markings from a surface comprising rotating nozzles so as to direct jets of ultra high pressure fluid on to the surface and moving the nozzles across the surface.

20. A method according to Claim 19, wherein the fluid is water at a pressure greater than 1400 bar.

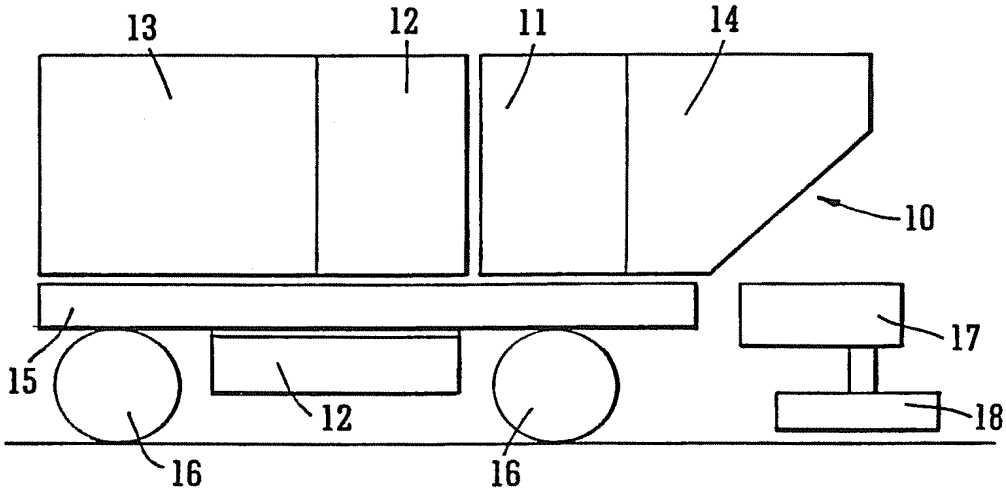

FIG. 1

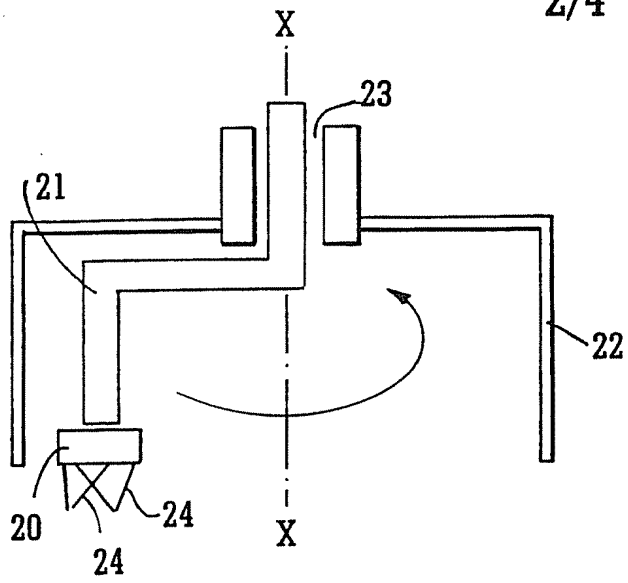

FIG. 2

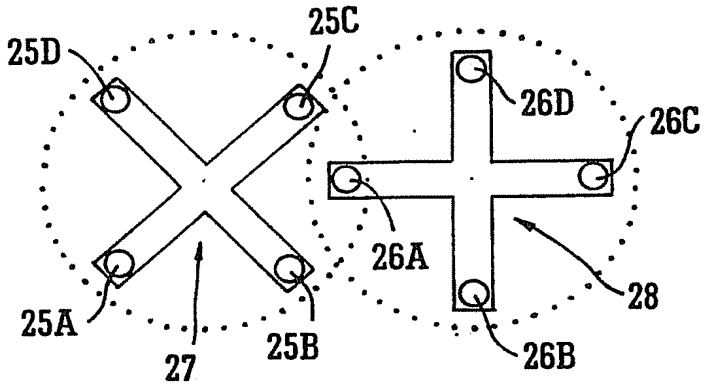

FIG. 3

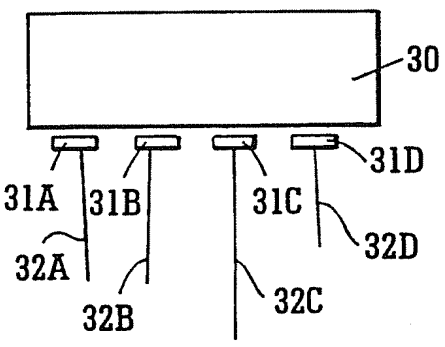

FIG. 4

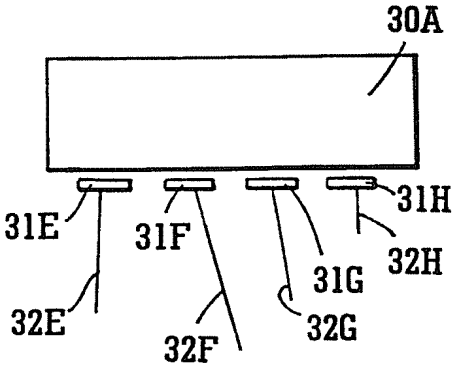

FIG. 5

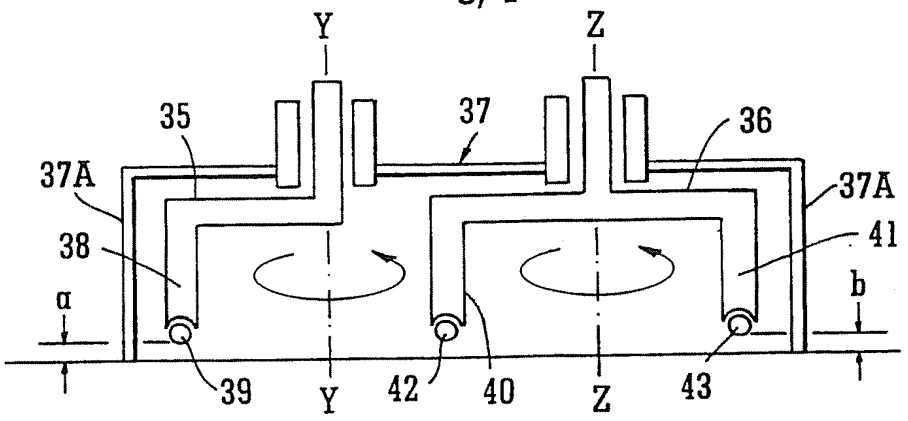

FIG .6

a=b or a=/=b

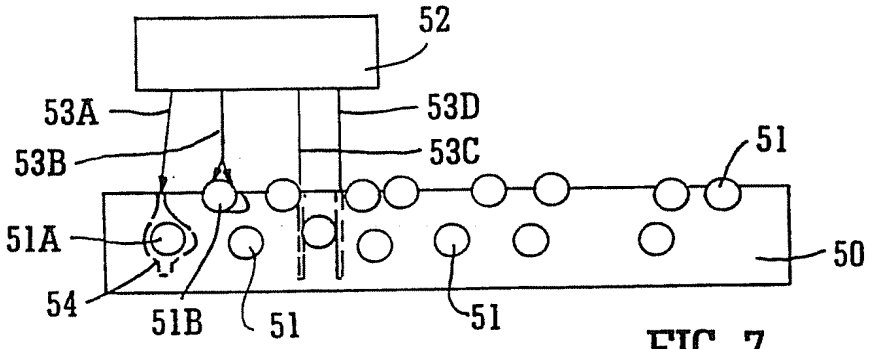

FIG. 7

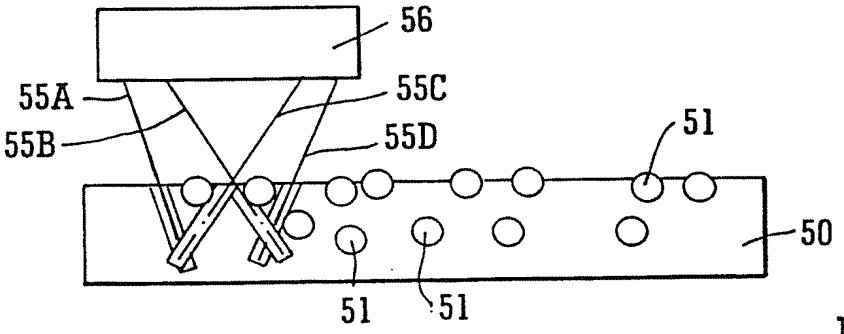

FIG. 8

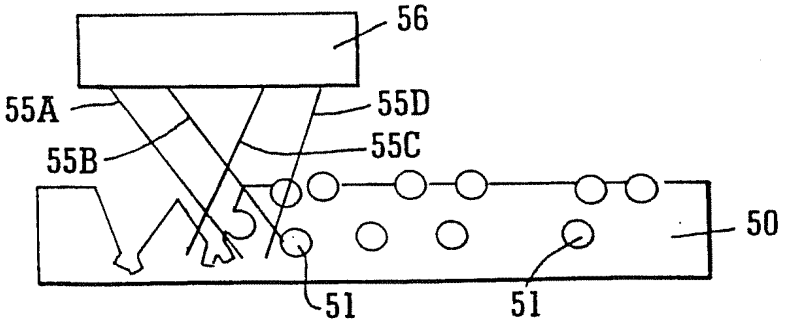

FIG. 9

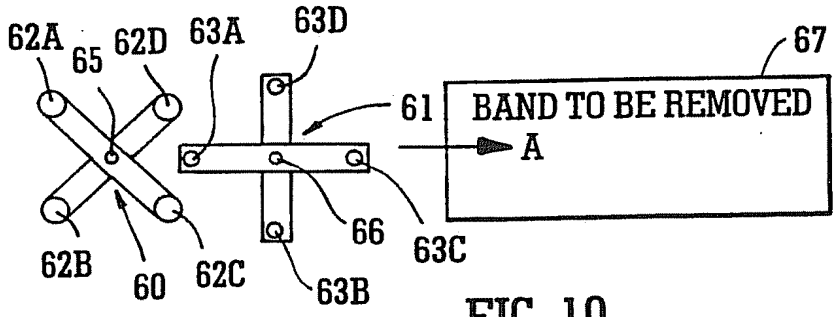

FIG. 10

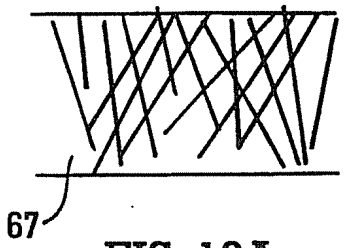

FIG. 10A

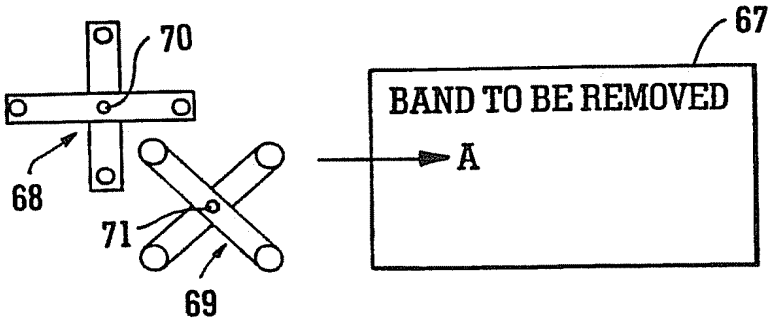

FIG. 11

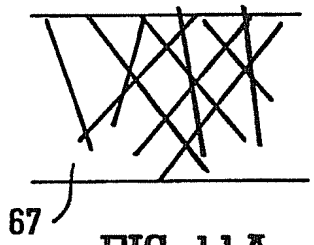

FIG. 11A

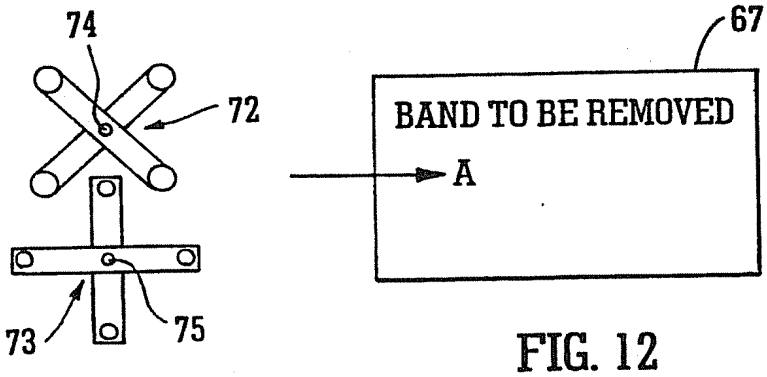

FIG. 12

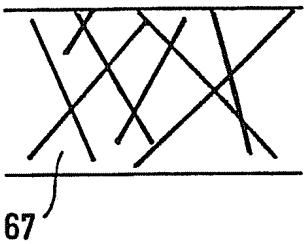

FIG. 12A

INTERNATIONAL SEARCH REPORT

Interna[illegible] I Application No
PCT/GB 98/02969

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 E01H1/10 B08B3/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 E01H B08B E01C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 318 074 A (HAK A INT BV) 31 May 1989	1-3, 11-15, 19,20
Y	see the whole document	16-18
X	FR 2 750 898 A (COGEMA) 16 January 1998	1-3,7-10
Y	see the whole document	16
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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28 May 1999	07/06/1999

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European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Dijkstra, G

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INTERNATIONAL SEARCH REPORT

Internat Application No
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